

## PREFERENCE, NEOPHOBIA AND NUTRITIONAL QUALITY OF A WILD FRUIT "LENDJ" (*ARBUTUS UNEDO L.*) FROM ALGERIA

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### ABSTRACT

In Algeria, wild berries *Arbutus unedo L.*, known as "lendj" remain unexploited and little studies have been devoted to it. The presented work aims at, on the hand, studying the physicochemical and phytochemical characteristics of the fruit, on the other hand, conducting a survey of a school population of children aged 6 to 11 years old and adolescents aged 12 to 17 years old to determine the level of neophobia and preference of this fruit. The results show that lendj, with a carbohydrate content of 19.80%, which make it as an energetic fruit (100g lendj gives 103.47 kilocalories), as well as its riches in polyphenols ( $17.58 \pm 0.04$  mg EAG/g extract) and fibers (16%) attribute it a nutrient bioactive property feature. The acceptability of this fruit by the majority of the study population shows a mean preference score of 4.84, a rate which encourage its exploitation.

**KEYWORDS:** *Arbutus unedo L.* (lendj), Neophobia, Physicochemical Characteristics, Phytochemicals, Preference

### INTRODUCTION

The fruits of wild plants consumed mostly in the same locations of picking, do not fall in the balance of nutritionists who considered only fruit from cultivated plants. Currently, these products are attracting more and more scientific interest because of their availability, use, accessibility to various areas of research and their nutritional composition.

In Algeria, wild edible plants remain unexploited and their consumption is seasonal, but in the rural population, they are widely recognized. Among these plants include strawberry-tree (*Arbutus unedo L.*); forest tree with edible fruits known as vernacular Arabic name "lendj ". These fruits, sold on roadsides, are highly appreciated by the children Algerian populations.

Lendj has a very important medicinal and nutritional value; various studies have demonstrated the association of consumption of these fruits with a reduced risk of developing certain diseases such as hypertension, atherosclerosis and thrombosis and they are used in traditional medicine as antiseptics, diuretics and laxatives (Ziyyat et al, 2002; Mekhfi et al, 2006; El Haouari et al, 2007). The compounds involved in these effects may be found in the biochemical components and particularly the molecules from the secondary metabolism of the plant, including vitamins, polyphenols or triterpenes may act alone or in interaction (Ziyyat and Boussairi, 1998; Afkir et al, 2008; Mariotto et al, 2008).

In Algeria, very few studies have been devoted to the study of lendj; for this reason, we sought to collect data on their different physicochemical and phytochemicals characteristics and it appeared interesting to set up a survey of children and adolescents in school to study the knowledge level consumption and neophobia or preferences for a better exploitation and utilization of this product from a region in the northwest of Algeria (Tiaret).

## MATERIALS AND METHODS

### Materials

- **Lendj (*Arbutus unedo* L.)**

The fruits were gathered in November 2012, at different levels of maturity from forest of "Wadi el-lendj -Tiaret-"; region in the southwest of Algeria at an altitude of 1040 m, and was transported immediately to laboratory of the Faculty of Natural Sciences and Life, Tiaret.

- **Study Population**

Part of this study was devoted to the estimation of knowledge, exploitation, preference and neophobia of lendj. The target population in the hedonic tests, is children aged 6 to 11 years (305 children including 162 girls and 143 boys) and adolescents aged 12-17 years (195 adolescents including 77 girls and 118 boys) from different socio-economic levels enrolled in primary and secondary schools in 2012 - 2013.

## METHODS

- **Sample Preparation**

The ripe fruits were selected for the study. The lendj fruits, after being washed, wiped and sorted, were divided into two parts: the whole fruits served for tasting and morphological study and the other; fruits were crushed in laboratory blender and divided into batches, each batch is placed in a sterile container and stored frozen at  $-20^{\circ}\text{C}$  for analysis purposes. The crushed fruits have been used to obtain fruit juice and aqueous (10% maceration for 24 hours) and organic (methanol, acetone and ethanol) extracts.

- **Morphological Parameters**

The samples were obtained by taking 50 randomly lendj fruit. Each fruit was then subjected to physical measurements. The ripeness and the weight were studied first. Then, the length and the diameter of the fruit were measured with a micrometer caliper.

- **Biochemical Parameters**

On lendj crushed, were determined: dry weight ( $70^{\circ}\text{C}$  for 72 h), the ashes contents obtained after incineration in a muffle furnace (HEAREUS INSTRUMENTS) to  $500 \pm 25^{\circ}\text{C}$ , total sugars by the method of **Dubois et al. (1965)**, the lipids according to the **AFNOR standard (AFNOR, 1988)**, the protein according to the **Bradford method (Bradford, 1976)**. The insoluble fiber fraction is determined in a "Fibretec" (HEAT EXTRACTOR -1010) according to the method of Weende (**VanSoest and Wine, 1967**). On lendj juice, the pH is determined using a pH meter (SCHUTT GERATE CG- 822). The titratable acidity is performed according to the protocol of **Le coq (1965)**.

The energy value was calculated from the total carbohydrate content, protein and fat using the conversion factor energy of ATWATER, which is, for fruits: 3.60 Kcal per 1 g carbohydrate, 8.37 Kcal per 1 g of fat and 3.36 Kcal per 1 g of protein (**Linden, 1981**).

- **Phytochemical Parameters**

- **Detection of Secondary Metabolites**

The characterization of these substances has been made on aqueous and ethalonoic extracts. For the detection of different groups by chemical color reactions, according to **Ciulei (1982)**; it was limited to the detection of alkaloids by the reagent "Wagner", polyphenols and tannins by the  $\text{FeCl}_3$  test ; coumarins by the ammonia test followed by UV exposure ; flavonoids by cyanidin test. Other substances are also detected according to defined protocols, it is steroids (**Bruneton, 1996**), saponins (**Koffi et al, 2009**), anthraquinones (**Oloyede, 2005**), anthocyanins (**Bruneton, 1996**) and reducing sugars by the Fehling method.

- **Determination of Type of Alcohol**

The test of "Lucas" was made on the aqueous extract, which results in a reaction disorder: instantly with the tertiary alcohol, after 10 min with the secondary alcohol and negative reaction with the primary alcohol (**Lucas, 1930**).

- **Determination of Total Ploysphenols**

The determination of the total polyphenol content is carried out by the Folin - Ciocalteu method of Singleton and Rossi (**Singleton and Rossi, 1965**) using gallic acid as standard. The color produced, whose absorption is measured at 750 nm, is proportional to the amount of polyphenols present in the plant extracts, the results are expressed in mg EAG/ 100 g dry weight of plant material. Optimizing the analytical performance is achieved by extraction with different solvents: methanol/water (v/v 50:50), methanol/acetone (v/v 50:50) and acetone/water (v/v 70:30).

- **Test Acceptability of Lendj**

The acceptability of lendj is expressed by the aspects related to levels of recognition, consumption and neophobia fruit for each child and adolescent.

- **Performance of the Study**

A pre- survey of 20 pupils identified the difficulties encountered in order to make certain changes in the questionnaire used for the survey of 500 pupils. The subjects are interviewed individually and responses are noted after giving up explanations to help without influencing their answers.

The level of recognition of lendj is calculated by the ratio between the number of subjects recognizing the fruit and the total number of respondents. The level of exploitation is determined by the ratio between the number of subjects who consumed fruit at least once and the total number of subjects recognizing the fruit. Preferences were estimated by the choice of the child between five proposals coded with scores ranging from 2 to 6 (2: It disgusts me, 3: I don't like it, 4: I like it a little, 5 I like it, 6: I like it too much). The level of neophobia is evaluated by using the scale of facial expressions and Questionnaire Food Neophobia: QENA, with scores ranging from 1 to 4 (1: agree immediately to taste, 2: hesitate and taste, 3: hesitate and do not taste, 4: refused immediately to taste) (**Rubio et al, 2008**).

- **Statistical Analysis**

Data entry was performed by Excel 2007. Analyzes of the characteristics of lendj fruits were performed in triplicate. The results are expressed in percentage in the case of qualitative variables (aspect, the levels of recognition and consumption of the fruit) and mean  $\pm$  standard deviation in the case of quantitative variables (weight, diameter, physicochemical and phytochemicals parameters). The average scores determined for neophobia and comparing several means are made using the STSS Software Version 16 by the ANOVA test, the significance level is 0.05.

## RESULTS AND DISCUSSIONS

### Morphological Characteristics

Different stages of ripening coexist with a dominance of ripe fruit (red). Unripe fruits (green) are less represented (only 5%) and yellow and orange fruits represent respectively 10% and 35%. This confirms the presence of the different stages of ripening on the same tree.

The mean weight is  $4.46 \pm 0.01$  g, value very close to that found by **Molina et al. (2011)**:  $4.27 \pm 0.19$  g for a Spanish forest variety and higher than that found for a Turkish forest variety:  $0.70 \pm 0.027$  g (**Özcan and Haciseferogulları, 2007**). The mean diameter is  $1.85 \pm 0.01$  cm while that found by **Özcan and Haciseferogulları (2007)** is  $1.07 \pm 0.11$  cm. Different factors, as meteorological ones, can affect the size and weight of the fruit. Indeed, a study by **Molina et al. (2011)** shows the effect of these conditions on the morphological characteristics from one season to another, which was very significant.

### Biochemical Characteristics

The table 1 presents the results of various biochemical parameters (mean  $\pm$  standard deviation).

**Table 1: Results of Morphological and Physicochemical Analysis**

Parameters	Mean $\pm$ SD
Mean weight (g)	$4.46 \pm 0.01$
Mean diameter (cm)	$1.85 \pm 0.01$
Water content (%)	$63.67 \pm 2.39$
Ash content (%)	$1.36 \pm 0.74$
pH	$3.44 \pm 0.13$
Titrateable acidity (%)	$1.24 \pm 0.26$
Crude fiber (%)	$16 \pm 1.00$
Fat (%)	$0.62 \pm 0.11$
Total sugars (g/100g)	$19.80 \pm 0.01$
Proteins (g/100g)	$4.02 \pm 0.00$

The water content of lendj ( $63.67 \pm 2.39\%$ ) explains the perishable nature of the fruit; this result is comparable to those obtained from other *Arbutus* fruits with water contents ranging from 68.2% to 71.89% (**Bizouard and Favier, 1962; Ruiz-Rodríguez et al, 2011; Haciseferogulları and Özcan, 2007**). This variability of the water content can be attributed to the season, environmental conditions and provenance of the fruit (**Ruiz-Rodríguez et al, 2011**). Compared to a similar fruit morphologically; strawberry: *Fragaria x ananassa* D, lendj is less hydrated than the strawberry (89.5%) (**Regal, 1995**). The obtained value of ash ( $1.36 \pm 0.74\%$ ), is fairly representative of the presence of minerals in this fruit. This value is not far from that found by **Barros et al. (2010)** ( $1.71 \pm 0.09\%$ ). In view of these results, lendj could be considered a food of certain nutritional value for children. The acidic nature of lendj is revealed by the results obtained ( $\text{pH} = 3.44 \pm 0.13$ ), such a pH limit contamination and growth of many microorganisms except for acidophilic.

These results are similar to those of **Bizouard and Favier (1962)** and **Ruiz-Rodríguez et al. (2011)**, which are between 3.47 and 3.61 and lower than the value of  $4.6 \pm 0.1$  reported by **Özcan and Haciseferogulları (2007)**. This difference is due to the degree of ripeness of lendj. The total acidity (% citric acid) samples is  $1.24 \pm 0.26\%$ , it approaches relatively to those of **Ruiz-Rodríguez et al. (2011)** ( $0.92 \pm 0.61\%$ ) and **Sulusoglu et al. (2011)** ( $0.99\%$ ), but remains lower than those of **Özcan and Haciseferogulları (2007)** ( $5.97 \pm 0.01\%$ ) and **Aslantaş et al. (2007)** (2.23 - 6.65%). This change in acidity can be explained by the degree of ripening fruit picked. Compared with another

fruit; strawberries are more acidic than lendj berries (titratable acidity varies from 5.9 to 8.4%) (Carlen et al, 1964), this justifies the consumption of this fruit by children without added sugar. Assay results of fat and protein give a mean of  $0.62 \pm 0.11\%$  and  $4.02 \pm 0.00\%$  respectively. These results indicate that lendj is not a lipid source, so the fruit is not recommended for coverage of lipid energy needs of the body. Compared to other works, this result is lower than that found by Özcan and Haciseferogulları (2007) (2.1%) and higher than that of Favier et al. (1993) (0.4%). Although this value is low, other studies have shown that the proportion of polyunsaturated fatty acids is overrepresented (52%) with a high ratio  $\omega 3/\omega 6$  in *A. unedo* fruit; which gives it a particular nutritional interest (Oliveira et al, 2011). Lendj is not an important source of proteins; Nevertheless, the value found is higher than those of Özcan and Haciseferogulları (2007) (3.36%) and Barros et al. (2010) (3.09%). The sugars' results show that lendj is a carbohydrate food with a content of  $19.80 \pm 0.01\%$  compared to fruits commonly consumed in Algeria such as orange, peach, apricot and loquat whose values are 9.8%, 11.3%, 8.02% and 9.1% respectively (Ciquel, 1993). Variable levels of sugars (14.11 to 31.55%), depending on the season and region, were obtained with Spanish varieties (Ruiz -Rodríguez et al, 2011). The determination the energy value of lendj, shows that 100g lendj provides 103.47 kilocalories; this result shows that lendj is essentially a carbohydrate fruit that is, like most of fleshy fruit, a significant energy source for human consumption. This value covers 6% of the energy needs for the age group 5 - 9 years and 5% for the age group 10 - 13 years old children (Favier et al, 1993). The insoluble fiber content ( $16 \pm 1\%$ ) is consistent with those found by Ruiz -Rodríguez et al. (2011), which ranged from 7.86 to 18.55%, thus classifying this fruit among those containing an appreciable level of indigestible carbohydrate. It then appears that 100g of lendj cover 15.23% sugar, 64% dietary fiber and 21.05% protein for children aged 4 - 8 years, with reference to the RDA (Recommended Dietary Allowances) recommended by Trumbo et al. (2002).

### Phytochemical Characteristics

Phytochemical analysis results are shown in table 2. The phytochemical screening performed on lendj revealed the presence of catechol tannins, flavonoids, saponins, phenolic derivatives, steroids and coumarins. Phenolic compounds (tannins, flavonoids) and saponins are the most abundant and best known secondary compounds lendj, which also synthesize other secondary compounds such as saponins (Dib et al, 2011). These results are in agreement with other works that confirm the presence of these phytochemicals in lendj and give it functional properties (Afkir et al, 2008; Mariotto et al, 2008; Pallauf et al, 2008; Ruiz-Rodríguez et al, 2011). It should be noted, that the Lucas test for alcohol was positive and revealed the presence of tertiary alcohol in lendj; This is confirmed by the work of Coelho et al. (2006) which showed the presence of terpenes (relative to the presence of alcohol) in the fruit of *Arbutus unedo* L.

The determination of total polyphenols by different extracts of the fruit of *Arbutus unedo* L, shows that the methanol extract contains the highest content with  $17.58 \pm 0.04$  mg EAG/g of extract. The values of extracted using acetone and water as solvents are very close ( $15.19 \pm 1.17$  mg EAG/g extract and  $14.4 \pm 0.86$  mg EAG/g respectively). While the combination of methanol and acetone is not interesting and has the lowest content ( $7.56 \pm 1.3$  mg EAG/g extract only). Several studies have confirmed that lendj is an important source of polyphenols which include groups such as tannins, flavonoids, anthraquinones and steroids, known for their effect on reducing the risk of cancer, heart disease and other degenerative diseases. They also represent a support for the main organoleptic and antioxidant properties (Afkir et al, 2008; Mariotto et al, 2008; Pallauf et al, 2008; Fortalezas et al, 2010).

**Table 2: Results of Phytochemical Analysis**

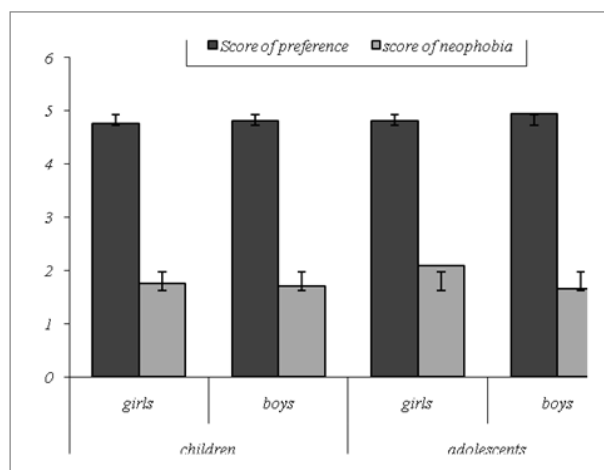
Parameter	Results
Catechol tannins	+++
Flavonoids	+++
Saponins	+++
Anthraquinones	+++
Alcaloids	++
Steroids	++
Coumarins	+
Anthocyanins	+
Test of Lucas	Presence of tertiary alcohol
<b>Polyphenols* (mg EAG/g Extract):</b>	
• Methanol/water	17.58 ± 0.04
• Acetone/water	15.19 ± 1.17
• Water	14.4 ± 0.86
• Methanol/acetone	7.56 ± 1.30

+++ : Clearly Positive Result, ++ : Positive Result, + : Averagely Positive Result

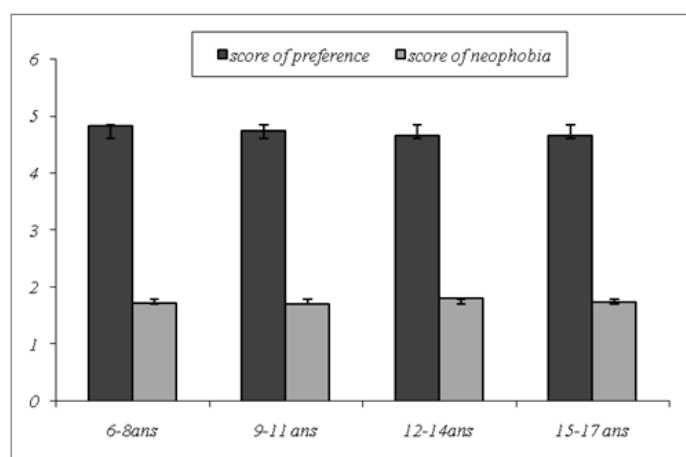
\*: Results are a Mean of 3 Repetitions ± Standard Deviation

### Results of the Test Acceptability of Lendj

The lendj fruit is known by the majority of the population (90%), but it is not exploited by 60% of the population. The test acceptability of lendj shows that the fruit is moderately appreciated by children and adolescents and the difference is not significant in child population. In addition, a significant difference ( $p = 0.002$ ) was noted between sexes in adolescents (figure 1). In children, the mean score of neophobia of lendj is  $1.76 \pm 0.93$  for girls and  $1.70 \pm 0.93$  for boys. Whereas among adolescents, girls score significantly higher than boys ( $p = 0.002$ ) (figure 2). No significant difference was observed between the different age groups for both sexes.



**Figure 1: Mean Hedonic Score of Children and Adolescents According to Sex Groups**



**Figure 2: Mean Hedonic Score of Children and Adolescents According to Age groups**

This study of hedonic evaluation of lendj is a first in Algeria. It shows the acceptability of the fruit by the majority of the population with a mean score of preferences of 4.84 and a very high level of recognition (90%). This can be explained, firstly, by the fact that lendj is familiar to the child, so he agrees to eat it, and secondly, it is not exploited by the population because of its lack on the shelf. The whole of study population did not show a significant score of neophobia to this fruit picking. Only adolescent girls refuse the fruit with a mean score of 2.09; they show their distaste for the fruit for the reasons: bitter fruit, presence of seeds confers a grainy texture and unattractive appearance. Few studies have really reviewed the reasons of hedonic value searched in specific products, or differences in this value by the consumption of fruits and vegetables (Schaffer, 2003). Studies conducted on strawberry by Roty and Hutchinson (2001), show that the sensory characteristics of the strawberry can be used to feel emotions related to its red color or its shape, offering more psychological than gustatory pleasure. However, we can deduce that the *Arbutus* fruits, also called "strawberry tree" because they remind the appearance of strawberries; can cause the same sensory characteristics especially in children.

## CONCLUSIONS AND PERSPECTIVES

The study of biochemical and phytochemical composition of lendj, shows that this fruit provides an important energetic contribution (103.47 kilocalories per 100g of fruit) and bioactive compounds in health protection namely polyphenols (17.58 mg EAG/g extract) that are antioxidants (Pallauf et al, 2008; Mariotto et al, 2008) and dietary fiber (16%). These results help to do from lendj a fruit of choice for called vulnerable consumers; children, and encourage its consumption as an interesting alternative in the aim of its valorization. Only its high water content is the major limiting factor for its conservation in the fresh state. For this class of fruit, seasonal and quickly perishable after picking; initiation to "new" practices could help to give him a greater interest; for example, the production of jellies, jams or other product to increase the availability of lendj in time. The conservation processes must preserve the maximum sensitive nutrients (such as Vitamin C and polyphenols) which allow, on the one hand, increasing the shelf life, and secondly, an increase in the hedonic value related to the number of sequence of exposure of the fruit (Birch, 1987).

The acceptability of the fruit is very interesting for age 6 - 17 years old, with a high score of preference (4.84), a very high level of recognition (90%) and a low score of neophobia (1.73), these results getting ready to promote its exploitation which still low (40%). These characteristics can be taken into account in a selection program of fruits with weights and diameters important. A study of several seasons in Algeria can therefore be very interesting. Our results show

the need for a controlled *Arbutus unedo* L. trees to get a better quality fruit cultivation as the absence of a selection of these trees threatens its future.

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